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Volcán de Colima

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INTRODUCTION

Volcán Colima is currently one of the most dangerous volcanoes in Mexico. It presents hazards at various scales. It has a history of frequent eruptions during the past 450 years, for which there are written records. To better understand the nature of the volcano and predict its future activity, the level of scientific investigation has greatly increased in recent years. The articles in this volume summarize current information on a variety of topics related to the geology and geophysics of the Colima. They were assembled as part of a co-operative scientific project to analyze and mitigate the risk at this volcano.

The first part of this volume deals with the tectonic setting. Delgado's paper is an overview of numerous studies, including his own recent work. The paper by Bandy and others deals with geophysical research done primarily on the graben. A series of papers on the petrology of Colima volcano and the surrounding area are included. Macías and others discuss the regional characteristics from the geochemical point of view. The early Colima lavas were studied by Robin and Potrel and by Luhr; both papers reflect the detailed studies done by these authors. The paper by Verma and Luhr deals primarily with the isotopic constraints of the Colima magma. Two papers on the volcanic geomorphology (Lugo and others) and fault morphology (Ortíz and others) are presented. Connor and others have included a paper on the thermal characteristics of the Colima dome. Murray, González and others, and Lermo and others present papers on seismic and deformation work done on the volcano, the last two during the 1991 eruption. Don Juan Vizcaino, the chronicler from Ciudad Guzmán has sent a summary of his observations since the 1930's.

In the past, Colima has produced various volcanic phenomena including: earthquakes, ash falls, rock slides, mud flows, lava flows, pyroclastic flows, cataclysmic avalanches, and caldera fomation. Due to its location, this volcano presents a potential risk to the lives and property of more than 400,000 people who live in areas near the volcano. The main railroad line connecting Manzanillo with the interior of the country runs along the base of the volcano as does a major power line and both could be severed by the products of the next large eruption. Likewise, the highway between Manzanillo and Guadalajara or Mexico City also passes bnear the base of the volcano.

The geological and geophysical history of Volcán Colima provides the basis for assessment of the hazards and development of a plan for risk mitigation.

During the past 450 years the volcano has experienced dormant periods measured in decades, which follow the violent emission of ash flows and widespread fall of plinian scoria characteristic of the culminating phase of a cycle that occurred with intervals of centuries.

Eruptions that come after quiescence begin with effusion of lava and growth of a summit dome. Each historic cycle ended with the cataclysmic outpouring of incandescent ash and scoria. The average cycle lasts about 70 years; the previous cycle ended in 1913 and the volcano is now nearing the end of a new cycle. The current pattern of activity suggests that Colima may reach another cataclysmic state within a decade or two.

The intensity of the expected cataclysmic phase will probably be similar to that of the previous cycle. That activity ended with the explosive eruption that occurred on January 20, 1913. Without any premonitory phenomena, a tremendous plinian eruption began. The dominant winds carried the ash cloud to the NE, depositing tephra on the flanks of Nevado, Ciudad Guzmán, Guadalajara and cities further north. Ash flows rushed down major canyons on the southern sites of the edifice and terminated as far as 15 km from the summit crater. The top of the existing cone was destroyed and a deep crater was formed at the summit. This eruption was very sudden and violent, and lasted only four days.

The recent succession of volcanic eruptions should be considered in relation to past cycles with a recurrence interval measured in centuries. Following the 1913 eruption the volcano was essentially dormant, although the lava dome slowly rose from a depth of more than 60m to the crater in 1957. In 1961 a lobe of the lava flowed through the lowest point in the northern rim of the crater yielding a small andesite lava flow which continued down the northern flank of the volcano. Larger flows of blocky lava spilled over the NE and SE crater rims in 1975 and 1976.

In 1981-82 a small lava flow came down the southern flank. During the 1980's the summit was characterized by permanent fumarolic activity and a red glow could sometimes be observed at night. Small landslides were common on the flanks of the cone. A small phreatic explosion at the summit occured on July 2, 1987, triggering several dry landslides on the steeper flanks of the volcano. Secondary lahars were also produced on the southwestern flank of the volcano. The most recent eruptions in March and April of 1991 produced rock avalanches, a small summit dome which eventually grew to create a lava flow down the SW

side of the volcano accompanied by a series of small block and ash flows. This activity confirms the interpretation that the series of eruptions that began in 1961 will likely increase in frequency and intensity, culminating in cataclysmic explosions like those that occurred in 1913.

Much larger events involving sector collapse of the volcano with attendant huge volcanic debris avalanches have a recurrence interval measured on a longer time scale of millennia. The city of Colima rests on products of such giant avalanches and mudflows. An avalanche that slid from Nevado de Colima and reached the Pacific Ocean, 110 km distant, devastated everything in its path. Considering the present condition of the volcano, there is a finite unknown possibility that such an event could occur in the near future.

At least 200,000 people live within 50 to 70 km of Volcán de Colima. A much greater population lives along major drainage systems with tributaries which originate directly on the volcano's slopes. Manzanillo, 89 km southwest from the volcano, and Guadalajara, 120 km north from Colima, could be affected by a cataclysmic eruption. The city of Colima, 30 km southwest of the volcano, and Ciudad Guzmán, 30 km northeast of the volcano, would be affected by even smaller events.

People living in the vicinity of the volcano are susceptible to direct and indirect hazards from various scales of volcanic phenomena. Direct risks include death, injury, and other health hazards as the result of plinian tephra falls (ash and pumice), debris-avalanche events, pyroclastic flows, volcanic debris-flows or lahars, pyroclastic blasts and surges, lavas flows, different types of explosions (phreatic, phreatomagmatic), and earthquakes related to the active volcanic-tectonic environment. Important factors governing the number of potential victims include: (1) the nature and volume of volcanic products erupted; (2) the rapidity of the volcanic phenomena; (3) the duration of the activity; (4) the diversity of simultaneous eruptive phenomena; and (5) the fraction of the population subjected to the volcanic activity.

Indirect risks from volcanic activity are related to the widespread discruption of community services such as the break-down of electricity and water supplies, comunications (radio, telephone, TV), transportation (road, railroad, air traffic), health services, and particularly the impairment of emergency systems. As a consequence, the ability of public officials and scientists to disperse crucial information about the eruption and the course of action to follow is seriously limited. Other hazards such as forest fires ignited by lava flows and incandescent tephra, torrential rainfalls associated with the eruption, the collapse of dams as the result of overflowed drainage systems, and the production of large volumes of sediment can all greatly enhance risks to life and property.

Volcanic eruptions can also cause great damage to property, including various components of the infrastructure; schools, hospitals, factories, private homes, roads, bridges, and aqueducts. Agricultural resources (crops, cattle, and farming fields) will also be greatly affected by the emplacement of various volcanic deposits. The major elements at risk include a paper mill in Atenquique, a sugar cane factory in Quesería, as well as extensive sugar cane crops to the southeast of the volcano. In short, the entire local and regional economy could be disrupted following a major volcanic crisis, hence the importance of continuing volcanic studies.

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